EXECUTIVE SUMMARY

This report summarizes current and potential future conditions of air quality and air pollution impacts in national parks of the Rocky Mountains and northern Great Plains region, and recommends monitoring and research activities that could be implemented to acquire critical new data. The focus of this report is on the effects of criteria pollutants (ozone, SO_2, NO_x, particulates) on air quality and on air quality related values (terrestrial vegetation, aquatic systems, visibility). Other pollutants (e.g., H_2S, fluoride) are also discussed for specific locations where these pollutants may have potential impacts on natural resources.

In general, air quality in the Rocky Mountains and northern Great Plains region is considerably better than in most other areas of the continental United States. This is primarily due to the absence of high levels of fossil fuel combustion associated with metropolitan areas and because atmospheric conditions are not highly conducive to the formation and accumulation of ozone. Although current air quality is good in most areas except the Front Range of the Colorado Rockies, some pollutants may have potential impacts on national park resources in both the short- and long-term future.

Emissions in the Rocky Mountains and northern Great Plains come from a variety of sources. Nearly all SO_2 emissions and over 70% of NO_x emissions are produced from fuel combustion by electric utilities and other industrial processes. High emissions of NO_x and VOCs in Colorado, particularly in the greater Denver metropolitan area, result in synthesis of relatively high concentrations of tropospheric ozone.

Ozone appears to be an imminent concern only at Rocky Mountain NP, which is the recipient of air masses originating from the Denver-to-Fort Collins area during the summer. There are known sensitive vegetative bioindicators in the park, including ponderosa pine, quaking aspen and two lichen species. Because of the potential for increased ozone exposure in the park as the human population increases east of the Front Range, it is recommended that additional ozone monitoring be conducted and that vegetation monitoring plots be considered.

Atmospheric nitrogen deposition is an important environmental concern at the present time only in Rocky Mountain NP. Moderately high levels of N deposition, coupled with high watershed sensitivity to acidification, have likely contributed to some episodic acidification of surface waters in this park at current levels of nitrogen deposition. Relatively small amounts of chronic surface water acidification also cannot be ruled out. Continued or increased monitoring of surface water resources in Rocky Mountain NP is recommended.

A high degree of sensitivity to acidification was also demonstrated for surface waters in Grand Teton NP, although current levels of deposition are somewhat lower than in Rocky Mountain NP. Again, continued or increased monitoring of surface water resources is advised. In both Rocky Mountain and Grand Teton NPs, high elevation lakes constitute an important sensitive aquatic resource of concern.

Sulfur deposition currently is low at most of the parks in the region, and at current levels of deposition does not appear to be a major concern with respect to acidification of lakes and streams. However, emissions of SO_2, as well as H_2S, from many small oil and gas production facilities in North Dakota may have potential impacts on vegetation on a regional (for SO_2) and local (for H_2S) basis in Theodore Roosevelt NP. Sulfur deposition should continue to be monitored throughout the region. Emissions of sulfur compounds in North Dakota will likely increase in direct proportion to the number and productivity of active oil and gas wells. Sulfur dioxide concentrations may increase considerably throughout the Rocky Mountains and northern Great Plains if additional coal-fired power plants are built, because these new sources would have the potential to disperse pollutants long distances.

Visibility is a source of concern for all parks in the Rocky Mountains and northern Great Plains because of the magnificent vistas viewed from within and looking into the parks. In general, the best visibility in the conterminous United States typically occurs in the Great Basin, Colorado Plateau, and Rocky Mountains. Regional and local pollution sources that appear to contribute to visibility impairment throughout the Rocky Mountains and northern Great Plains include automobiles, coal- and oil-fired power plants, smelters, wildfires, and urban emissions. Average concentrations of

sulfates, organics, and elemental carbon are highest in summer, while nitrate concentrations are generally highest in winter and spring.

National Park Service monitoring data from 1988 to 1995 show that the annual average standard visual range for the central Rocky Mountains (represented by monitoring data from Rocky Mountain NP and Yellowstone NP) is 123 km; organics are the largest contributor to annual aerosol extinction (29%), followed by sulfates (24%). The annual average standard visual range for the northern Rocky Mountains (represented by monitoring data from Glacier NP) is 69 km; sulfates are the largest contributor to annual aerosol extinction (32%), followed by organics (28%). The annual average standard visual range for the northern Great Plains (represented by monitoring data from Badlands NP) is 85 km; sulfates are the largest contributor to annual aerosol extinction (40%), followed by organics (18%).

Long-term future visibility impairment may result from increased organics and elemental carbon concentrations due to possible increased gas and mineral developments. In the central Rocky Mountain region, higher organic concentrations may result from increased population growth along the Colorado Front Range. Visibility may also be affected by prescribed fires and wildfires, with the specific effects of fire on visibility varying interannually depending on the frequency and intensity of fires adjacent to a specific park and on climatic conditions.

Because relatively little is known about the dispersion of air pollutants in the Rocky Mountains and northern Great Plains, the contribution of pollutants from distant metropolitan areas such as Salt Lake City or from coal-fired power plants is poorly quantified. In addition, there are few data on the pollutant sensitivity of the native flora of this region. Finally, there is little information on the aquatic chemistry of the thousands of lakes and streams in the mountainous parks. Having this sort of data would greatly enhance the ability of national park resource managers to anticipate and identify potential impacts. We encourage the National Park Service to participate in modeling and data collection efforts, in cooperation with other agencies when appropriate, that would augment current knowledge about the impacts of air pollution on terrestrial and aquatic resources in the region.

We recommend that the National Park Service consider at least some additional monitoring of air quality in most of the parks discussed in this report. For example, short-term quantification of the spatial patterns of ozone exposure using passive samplers is an inexpensive way to establish a reference point in time. While continuous analyzer data for ozone and SO_2 are more expensive to obtain, it is the best way to obtain a reference with which future conditions can be compared. Monitoring in combination with modeling is an ideal mechanism for estimating the impacts of local sources, especially for aquatic effects, SO_2, and visibility. Similarly, additional measurements of acid neutralizing capacity and other characteristics of high mountain lakes will establish a reference and identify potentially sensitive resources, should air quality deteriorate in the future. Types and locations of monitoring are suggested in this report, should there be sufficient interest and funding for such activities in the future.